

# Status of the Dragon 2 Programme at the Mid Term Stage

Yves-Louis Desnos <sup>a,\*</sup>, Zengyuan Li <sup>b</sup>, Andy Zmuda <sup>c</sup>, Zhihai Gao <sup>b</sup>

<sup>a</sup> ESA Science and Applications and New Technologies Department, Directorate of EO Programmes ESA/ESRIN 00044 Frascati Italy, Email: yves-louis.desnos@esa.int

<sup>b</sup> Research Institute of Forest Resources Information, Chinese Academy of Forestry and on behalf of National Remote Sensing Center of China (NRSCC), Beijing, P.R. China  
Email: zengyuan.li@caf.ac.cn

<sup>c</sup> Serco co ESA / Science and Applications and New Technologies Department, Directorate of EO Programmes ESA/ESRIN 00044 Frascati Italy Email: andy.zmuda@esa.int

**Abstract - The cooperation between ESA and National Remote Sensing Center of China (NRSCC) / Ministry Of Science and Technology of China (MOST) in the development of Earth Observation (EO) applications started 15 years ago. In 2004, a new phase in cooperation began with the start of the Dragon Programme which focused on science and application using ESA satellite data. The programme was completed in 2008. Following on, the cooperation took on greater momentum with the start of a four-year science and exploitation programme called "Dragon 2". This programme brings together joint Sino-European teams to investigate land, ocean and atmospheric applications in P.R. China using data from ESA, Third Party Mission and Chinese Earth Observation satellites. Here-in provided is an overview of the results, reporting and training activities at the mid term stage of the programme (2008 to 2010). The programme provides a platform for the joint exploitation of EO data from optical, infrared, thermal and microwave sensors for science and application development.**

**Keywords:** Land, ocean, atmosphere, ESA, NRSCC, China

## 1. INTRODUCTION

### 1.1 ESA, MOST China collaboration

The Dragon 1 programme (2004 to 2008) namely concerned the exploitation of ESA ERS and Envisat data for science and application development in China, ESA SP-655, 2008. Following the success of the 1<sup>st</sup> programme, ESA and NRSCC launched "Dragon 2" as a follow on programme in 2008. The main objectives are similar to Dragon 1 but also include the use of data from ESA, Third Party Mission (TPM) and Chinese EO satellites. Following an Announcement of Opportunity (AO) in 2007 and review, 25 projects were selected. Dragon 2 brings together leading joint Sino-European teams and the programme formally commenced at the [Kick-off Symposium](#) that was held in Beijing in April 2008. Information about the teams, the participating institutions, study areas and projects' science and application development can be found on the [Dragon 2 website](#).

### 1.2 Objectives

The programme objectives are summarised as follows:

1. To promote the use of ESA, TPM and Chinese EO data for science and application development
2. To stimulate scientific exchange in EO science and application by the formation of joint Sino-European teams
3. To publish co-authored results at the mid term stage and at the end of the programme
4. To provide training to European and Chinese scientists for the exploitation of ESA, TPM and Chinese EO data in land, ocean and atmospheric applications.

### 1.3 ESA, TPM and Chinese EO Satellites

A compliment of EO data is being provided from ESA, Third Party Mission (TPM) and Chinese EO satellites. On the ESA side, data from the ERS 1 and 2 satellites are provided to support long term monitoring applications as the archive now dates back to 1991. This archive coupled with Envisat data availability since 2002, provides 20 years of satellite based observations. Since the start of the Dragon 2 Programme in 2008, new satellite missions have been launched which includes the ESA Explorer missions and the Chinese Huanjing constellation. Table 1 provides a summary of the satellite missions for which data is being provided within the framework of Dragon 2.

Table 1. ESA, TPM and Chinese EO satellites in Dragon 2

<u>ESA and TPM satellites</u>	<u>Chinese satellites</u>
ENVISAT	Beijing-1
ERS 1 and 2	CBERS
SMOS	FY-3
PROBA	HJ-1-A/B/C
ALOS	

### 1.4 Projects' Thematics

Following the joint ESA and NRSCC AO for exploitation of EO data, 25 projects were selected covering land, ocean and atmospheric applications. Figure 1 provides a breakdown of the projects by thematic application domain.

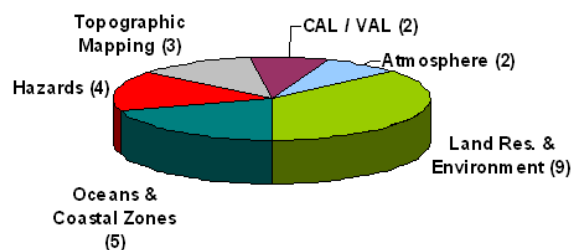


Figure 1. Thematics for the 25 Dragon 2 projects

### 1.5 Project Reporting at Annual Symposia

The joint teams came together for the first annual reporting at the World Trade Centre in Barcelona from 22 to 26 June 2009. There were 142 participants, comprising of 72 Europeans and 70 Chinese. All of the technical presentations are available to view [on-line](#). There were 48 poster papers presented dedicated to the reporting of the research undertaken by the young scientists engaged on the programme.

The Guilin Symposium took place from 17 to 21 May 2010 and was the occasion of the joint teams' reporting at the mid term stage of the programme. There were 252 participants. The Symposium was officially opened by the MOST China Vice Minister, Figure 2.



Figure 2. Official opening of the 2010 Guilin Symposium by Vice Minister MOST China, Dr. J. Cao

The teams reported on their latest results over 4 days in 2 parallel sessions. There were 54 technical presentations made, the abstracts are available to view [on-line](#). The Dragon 2 young scientists presented 68 poster papers. The next Symposium will be held in Prague, Czech Republic from 20-24 June 2011.

## 2. RESULTS

Following the call for papers that was opened ahead of the Guilin Symposium, ESA and NRSCC have published the programme results at the mid term stage of the programme. The proceedings are available on DVD as an ESA / NRSCC joint publication, ESA SP-684, 2010. The teams continue to deliver world class scientific results with papers also being published in leading scientific journals.

### 2.1 Land applications

One of the largest users of ASAR and PALSAR data within the Dragon 2 Programme is project id. 5305 which focuses on monitoring crustal deformations using repeat pass SAR interferometry. The study area is located in the Western region of China which undergoes surface deformation due to the large number of fault systems. In 2008 for example, the Wenchuan area of Sichuan Province was struck by a 8.0 magnitude earthquake which caused substantial loss of life and damage to the local infrastructure. Using the technique of repeat pass interferometry, the team have been able to show the surface deformation that occurred and have been able map the area suffering the worst damage. The results have been published in Nature Geoscience, Shen et al., 2009, Figure 3.

During the Forest DRAGON 1 project (2004 – 2008) forest growing stock volume (GSV) (also named stem volume) maps were produced for Northeast (~1,5 Million km<sup>2</sup>) and Southeast China (~3 Million km<sup>2</sup>) at 50 m spatial resolution from ERS-1/2 tandem coherence data (see Figure 4).



Figure 3. Front cover of Nature Geoscience

A new classification approach, based on synergy between the optical remote sensing product MODIS Vegetation Continuous Fields and ERS-1/2 tandem coherence has been developed for automatic and seasonal-adaptive retrieval of forest GSV, which is able to cope with multi-seasonal and multi-baseline data. The procedure integrates the semi empirical Interferometric Water Cloud Model and discriminates between four GSV classes (0-20, 20-50, 50-80 and >80 m<sup>3</sup>/ha), Cartus et al. 2010. The methodology developed is referred to as the DRAGON algorithm.

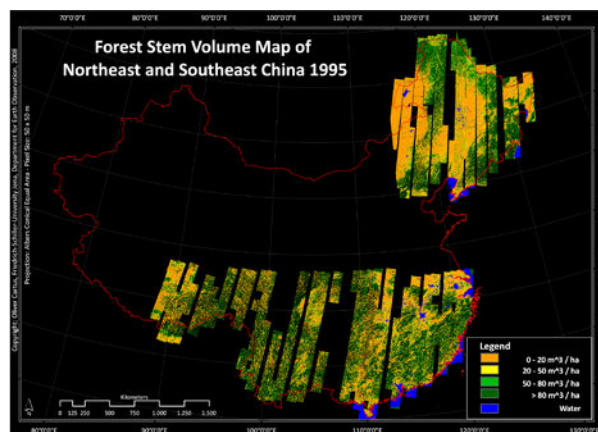


Figure 4. GSV maps of North East and South China from ERS SAR tandem data (courtesy of Dragon 2 project id. 5314)

The all weather day and night imaging capability of the ASAR instrument allows for flood monitoring and 2010 proved to be the worst year in China since 1998. Using ASAR imagery, the dynamics of Poyang Lake was monitored. ASAR imagery was acquired during the monsoon period and the Lake reached its full extent around 17 July 2010, as shown in Figure 5 and in Table 2. The team have been able to construct changes in the lake dynamics from 2003 to 2008 using optical and SAR data from ESA, TPM and Chinese EO satellites, Yésou et al. 2010.

Table 2. Flood dynamics of Poyang Lake monitored using ASAR WSM imagery, Project id. 5264

Flood extent (km <sup>2</sup> )	Date
3354.20	17 July 2010
3292.41	12 July 2010
3284.63	26 June 2010

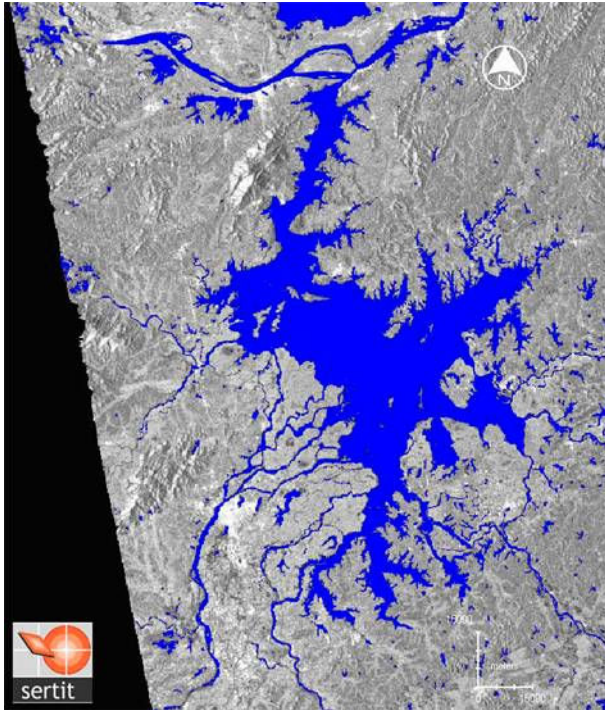


Figure 5. Poyang Lake flood extent (in blue) on 17 July 2010, from ASAR WSM imagery - Project id. 5264

Dragon 2 project id. 5297 is investigating the use of SAR time series to detect subsidence in cities and for monitoring the stability of large structures such as the 3 Gorges Dam. Research in Shanghai has shown that small scale deformations can be detected from space using Interferometric SAR (InSAR) and Permanent Scatterers InSAR processing techniques. The city has been suffering from subsidence since the 1920s. The EO derived subsidence rates show good agreement with bench mark levelling, Pei et al. 2010.

## 2.2 Atmospheric applications

Started under Dragon 1 and continued under Dragon 2, analysis of the long-term air quality data record from 1995 shows strongly increasing pollution levels in China, Van der A et al. 2010. An on-line air quality forecasting system has been developed (AMFIC), which uses the models to provide air quality forecasts for Chinese regions with a resolution of 1 km.

On a shorter time scale, the effect of emission reductions during the Beijing Olympic Games of 2008 has been studied. By comparing satellite observations with air quality model results, a reduction of approximately 65% above Beijing during the Olympic period was found, showing the success of the Chinese air pollution control efforts, Figure 6, Van der A et al. 2010.

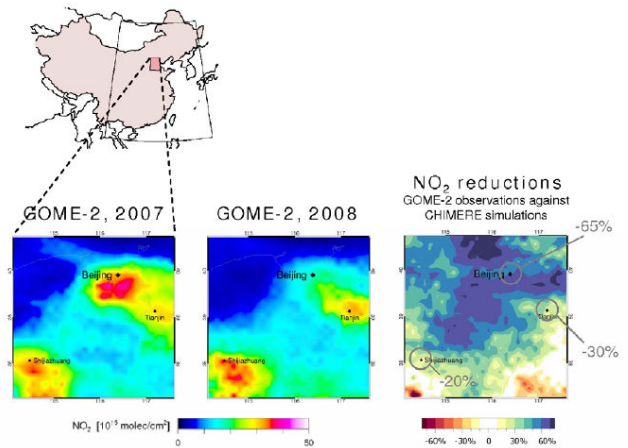


Figure 6. Tropospheric NO<sub>2</sub> columns by GOME-2 during the Olympic period (centre) and one year before (left), reduction in concentration (right) - Project id. 5253

## 2.3 Coastal and ocean applications

The Pearl, Yangtze and Yellow rivers drain into the South China Sea, East China Sea and Bohai Sea respectively. Research projects are on-going in each of the seas to map and monitor the distribution of Suspended Particulate Matter (SPM) and its validation. In the Changjiang estuary and coastal waters, sea cruises have been undertaken to measure bio-physical parameters and sea surface reflectance in 2008. These data have been used to establish calibration relationships between SPM and HY-1B COTS and MERIS imagery. Figure 7 shows the SPM on 1 March 2008 using Chinese EO data, Bai et al. 2010.

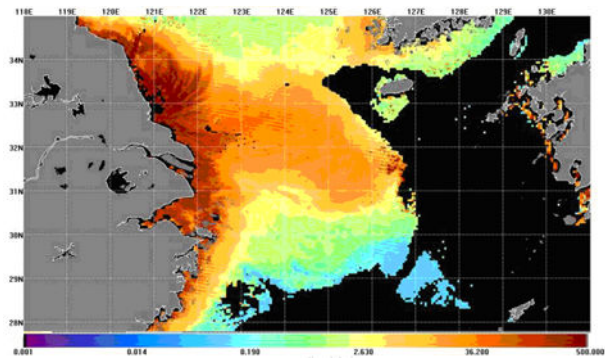


Figure 7. SPM concentration from HY-1B COTS imagery 01/03/08 (units are mg/L), Project id. 5351

New research within the Dragon 2 programme has been focusing on the information content of the Doppler shift for monitoring of China seas. The Doppler signal differs from a predicted signal based on the known motion of the satellite and the Earth's rotation. This Doppler signal difference is a measure of the line-of-sight velocity of the moving ocean surface and research is on-going into the use of ASAR Doppler shift for the detection of the Kuroshio current and for ocean wind retrieval. Figure 8 shows that using a time series of ASAR imagery and derived Doppler shifts, the Kuroshio surface current can be shown at higher spatial resolution compared to that derived from radar altimeter measurements, Hansen et al. 2010.

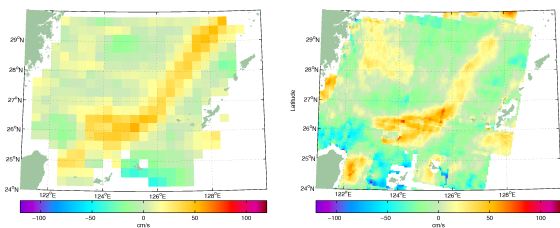


Figure 8. Mean ASAR Doppler current (right) compared with Radar altimetry (left), Project id. 5316

### 3. TRAINING

#### 3.1 Advanced courses

Since 2008, ESA and NRSCC have organised three advanced training courses in China as follows:

- The [2008 land training](#) course was hosted by Wuhan University, Wuhan in China and was attended by 60 trainees
- The [2009 atmospheric training](#) course was hosted by Nanjing University, Nanjing in China and was attended by 60 trainees
- The [2010 land training](#) course was hosted by the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI) and was attended by 80 students, Figure 9.



Figure 9. Lecture (left) and practical class (right) during the 2010 land training course, CAREERI CAS, Lanzhou, China

#### 3.2 Young Scientists Training and Academic Exchanges

A common objective of the Dragon 2 Programme is the training of young scientists in both Europe and China. ESA has placed contracts with 20 European Institutes to support the training of young scientists in Europe. In addition, several European and Chinese universities have made agreements to train Chinese scientists at Ph.D. level.

### 4. OUTLOOK

The Dragon 2 teams have delivered world class scientific results across a wide range of disciplines. In the remaining two years of the programme, the findings of the science and exploitation

development using ESA, TPM and Chinese EO data will be consolidated. The next reporting will be in 2011 in Prague, Czech Republic.

Three advanced training courses have been held in China since 2008. The next advanced training course will be in ocean remote sensing from 20 to 24 October 2011. The course will be hosted by East China Normal University (ECNU) and will aim to provide training in processing and product development from ESA and Chinese EO satellites including the new ESA Explorer missions, i.e. GOCE, SMOS and Cryosat-2.

The Dragon 2 young scientists are a key element to the success of the cooperation. Their reporting at annual Symposia testifies to the high quality of the research results. The final results proceedings will be published in 2012.

### REFERENCES

Y. Bai, X. He, D. Pan, H. Lei, Q. Zhu and F. Gong, "Validation of Ocean Colour Remote Sensing Data of HY-1B/COCTS," Proceedings of the Symposium, Dragon 2 Programme Mid Term Results, ESA SP-684, 2010.

O. Cartus, M. Santoro, C. Schmullius, P. Yong, C. Erxue and L. Zengyuan, "Creation of Large Area Forest Biomass Maps for Northeast China using ERS-1/2 Tandem Coherence," Proceedings of the 2008 Dragon Symposium, "Dragon 1 Programme final results (2004 – 2007)", 21 – 25 April 2008, Beijing, P.R. China, ESA SP-655.

M. W. Hansen, K-F. Dagestad, J. Johannessen, F. Collard and A. Mouche, "Mapping the Kuroshio Current with Synthetic Aperture Radar," Proceedings of the Symposium, Dragon 2 Programme Mid Term Results, ESA SP-684, 2010.

Y. Pei, L. Wei, Z. Fang, H. Wang, M. Liao, D. Li and M. Fang, "Monitoring Subsidence in Shanghai Combining Small Stack of SAR Images and Leveling Data," Proceedings of the Symposium, Dragon 2 Programme Mid Term Results ESA SP-684, 2010.

Proceedings of the 2008 Dragon Symposium, "Dragon 1 Programme final results (2004 – 2007)", 21 – 25 April 2008, Beijing, P.R. China, ESA SP-655.

Proceedings of the Symposium, "Dragon 2 Programme Mid Term Results 2008 to 2010", ESA SP-684, 2010.

Z-K. Shen, J. Sun, P. Zhang, Y. Wan, M. Wang, R. Bürgmann, Y. Zeng, W. Gan, H. Liao and Q. Wang, "Slip maxima at fault junctions and rupturing of barriers during the 2008 Wenchuan earthquake," Nature Geoscience, vol 2, p.p. 718 – 724, October 2009.

R. Van der A, B. Mijling, I. De Smedt, M. Van Roozendaal and H. Kelder, "Air Quality Monitoring And Forecasting In China," Proceedings of the Symposium, Dragon 2 Programme Mid Term Results, ESA SP-684, 2010.

H. Yésou, J. Li, S. Daillet, X. Lai, M. Bergé-Nguyen, X. Chen, S. Huang, J. Burnham, J-F. Crétaux, C. Huber, T. Marie, J. Li, S. Averty, R. Andreoli and C. Uribe, "Water Resource Monitoring Over The Yangtze Middle Reaches Exploiting Dragon Time Series, Envisat, Beijing 1, Altimetric Data and Field Measurements," Proceedings of the Symposium, Dragon 2 Programme Mid Term Results, ESA SP-684, 2010.